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A Minimization Penalty in Industrial Power Consumption by Engaging APFC Loop

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Abstract-The paper is designed to minimize penalty for industrial units by using automatic power factor correction unit. Power factor is defined as the ratio of real power to apparent power. This definition is often mathematically represented as KW/KVA, where the numerator is the active (real) power and the denominator is the (active + reactive) or apparent power. Reactive power is the non-working power generated by the magnetic and inductive loads, to generate magnetic flux. The increase in reactive power increases the apparent power, so the power factor also decreases. Having low power factor, the industry needs more energy to meet its demand, the efficiency decreases. In this proposed system we use four capacitor which is active by four relay circuit which is command by ATMEGA 328 when power factor below 0.9 one capacitor add in circuit and other add in condition as per power factor how low and depend on power factor controller give command to relay and capacitor connect in circuit the power factor get improve. The program takes over to actuate appropriate number of relays from its output to bring shunt capacitors into the load circuit to get the power factor till it reaches near unity. The microcontroller used in the project belongs to ATMEGA328.Further the project can be enhanced by using thyristor control switches instead of relay control to avoid contact pitting often encountered by switching of capacitors due to high in rush current.

Keywords**:** *Power Factor, Microcontroller, Reactive Power.*

1. INTRODUCTION

Automatic power factor correction device reads power factor from line voltage and line current by determining the delay in the arrival of the current signal with respect to voltage signal from the function generator with high accuracy by using an internal timer. This time values are then calibrated as phase angle and corresponding power factor. Then the values are displayed in the 2X16 LCD modules. Then the microcontroller calculates the compensation requirement and accordingly switches on different capacitor banks. This is developed by using microcontroller at mega 328 (IC). Automatic power factor correction techniques can be applied to the industries, power systems and also households to make them stable and due to that the system becomes stable and efficiency of the system as well as the apparatus increases. The use of microcontroller reduces the costs. The low power factor leads to the increase in the load current, increase in power loss, and decrease in efficiency of the overall system. The various conventional methods for the power factor correction are the using capacitors, microcontroller,

regulator, oscillator, condensers, etc. in all these methods, the switching of the capacitor or variation of the capacitance is not manual. In this project we are using a method of the reactive power compensation by capacitor switching with automatic control using microcontroller at mega 328(IC).The Reactive Power charge on your electricity bill is directly targeted against those companies who do not demonstrate clear energy efficiency use. Reactive power charges can be made significantly smaller by the introduction of Power Factor Correction Capacitors which is a widely recognized method of reducing an electrical load and minimizing wasted energy, improving the efficiency of a plant and reducing the electricity bill. It is not always necessary to reach a power factor of 1. A cost effective solution can be achieved by increasing your power factor to greater than 0.95.This project uses regulated 5V, 750mA power supply. 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer.

2. NEED OF POWER FACTOR CORRECTION

.Recent energy market deregulation, along with new potential energy supplier rising, had led to many and different type of invoicing which are not very clear in showing Power Factor up. However as energy final price is steady growing, to correct power factor is becoming more and more convenient. In most of the cases power factor improvement device prime cost is paid back in few months. Technical-economic advantages of the installation of a capacitor bank are the following:

• Decrease of the losses in the network and on the transformers caused by the lower absorbed current
• Decrease of voltage drops on lines.
• Optimization of the system sizing.

While cosφ increases, with the same absorbed power we can obtain a reduction in the value of the current and as a consequence the losses in the network and on the transformers are reduced. Therefore we have an important saving on the size of electrical equipment used on a System. The capacitor bank installation reduces Q so we have a lower voltage drop. If, for a wrong calculation of the installed capacitor bank value, the reactive part of the above equation becomes negative, instead of a reduction of the voltage drop we have an increasing of the voltage at the end of the line (Ferranti Effect) with dangerous consequence for the installed loads.

3. Hardware Requirement

- Power Supply
- LED
- Transformer
- Bridge Rectifier
- Diode
- Regulator
- Relay
- Resister
- Current Transformer
- Diode
- LCD
- ATMEGA328

4. ADVANTAGES & DISADVANTAGES

4.1 Advantages of improve power factor

- Improve voltage regulation
- Reactive power decrease
- Copper loss decreases
- Transmission loss decreases
- Improve voltage control
- Efficiency of supply system and apparatus increase

4.2 disadvantage of poor power factor

- Poor power factor means more line loss and low transmission efficiency
- More Capital Investment
- Large KVA rating of equipment - larger size and expensive
- Greater Conductor size required:
- Large Copper losses
- Poor voltage regulation

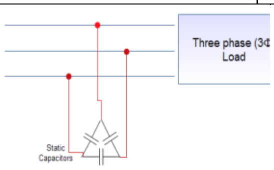
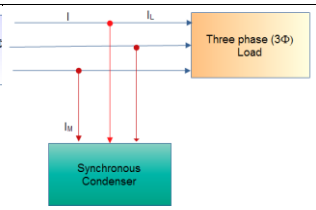
5. COMPARATIVE STUDY

Table No: 5.1Comparison between 8051 microcontroller and Atmega328:-

Atmega328	**8051**
Atmega328 is more faster than8051	8051 is less faster
It uses lesser number of clock cycle for instruction execution	It uses more clock cycle for instruction execution
It can use internal oscillator , saving additional circuitry	In 8051 to add external crystal Oscillator.
If you have to make small project which needs to	In 8051 you have to add an external EEPROM even

store only few bytes in EPROM,you can use internal EEPROM in atmega328	to store 1 byte.in addition you have to add more function in 8051
It much easier to use PWM in atmega328	It not easier to use PWM in 8051
Speed of atmega328 is 1cllock/ instruction cycle	Speed of 8051 is 12 clock / instruction cycle
It used modified architecture	It use Neumann architecture
It Bus width of 8/32 bit	It bus width is 8 bit for standard core

Table No: 5.2 distinguish between power factor improvement methods

System Parameter	Pf by Static capacitor method	Pf by Synchronous condenser method	Of by phase advancer method
Method	In the industries and power system loads are inductive that take lagging current which decrease the system power factor For Power factor improvement purpose, Static capacitors are connected in parallel with those devices which work on low power factor. These static capacitors provide leading current which eliminate the lagging component of load current thus power factor of the load circuit is improved.	When a Synchronous motor operates at No-Load and over-exited then it's called a synchronous Condenser. Whenever a Synchronous motor is over-exited then it provides leading current and works like a capacitor. When a synchronous condenser is connected across supply voltage (in parallel) then it draws leading current and partially eliminates the re-active component and this way, power factor is improved. Generally, synchronous condenser is used to improve the power factor	Phase advancer is a simple AC exciter which is connected on the main shaft of the motor and operates with the motor's rotor circuit for power factor improvement. Phase advancer is used to improve the power factor of induction motor in industries.
Diagrams			-
Maintenance	Little maintenance is required as there are no rotating parts.	Maintenance cost is high due to rotating components	Maintenance is high because it is connected to rotating parts
Installation	Easy connecting arrangement with less weight so it easy to installed	It not very easy to installed because it required extra equipment for use of excitations	It's difficult to installed because the phase advancer provider extra ampere turns of motor
Noise production	No noise production	It produce noise because of	It also produced noise

		rotating equipment	
Weight	Less	More	More
Losses	Low losses in this arrangement	More losses	More losses
Life	8-20 years	5-20 years	10-20 years
Cost	Less	More	More
Applications	It can apply any load for improvement of power factor	It use synchronous motor and synchronous equipment is not self-starting so extra excitations equipment is needed	This can be only used for the motor below 200 hp
Method used in MSEB & state	This Method is used in Dubai, Maharashtra the Pf ranges from 0 to 1 also its popular method commonly used in commercial, industrial and other application to improve Pf when it below 0.9.the panel of this method suppliers is at Uttar Pradesh and madya Pradesh.	This method used in Australia, build by Asia in 1966 of power 125 MW .North America is suppliers of this panel. This method is not more used in India. This method is not very popular method in industrial sectors.	This method is not so popular and it can be operated for small rating therefore it's used for lab testing.

6. Working Principle -

In above circuit diagram we give 230V AC Supply to transformer .there are two transformers is used power and voltage transformer. The voltage (small) transformer has 230 V input supply and 4V is output. This voltage transformer is used to measure voltage these 4 V output is forward to controller. From voltage (small) to power (big) transformer 230V supply is forward hence input of power transformer is 230 V AC and output is 12 V. this power transformer is used to provide power. Then this 12 V gives as input to w-10 bridge rectifier circuit. The w-10 bridge rectifier circuit is used to convert AC voltage into Dc output. This circuit is used 25 V, 1000 micro farad capacitor is used for filtering purpose and ln4007 diode is used for protection purpose. The register of 1 KOHM through one diode is connect it's for power indication purpose. The 12 V supply forward to 7805 Regulator it can be provide constant 5 V regulated supply to microcontroller atmega328 of vcc pin. Near to this atmega328 IC the two circuits is placed i.e. Oscillator and reset circuit the oscillator circuit consist of three components i.e. crystal oscillator of 16 MW and two 22 microfarad capacitor is used for filtering purpose. The reset circuit consists of 10K ohm register and 0.1 micro farad ceramic capacitor is used for filtering purpose and it placed output side of regulator. then from this all PCB we can take four output which give to relay driver IC(ULN2003)this driver IC has 5V input supply and it give GND to relay as we know that we can give by default 12 V supply to relay and also provide GND for start the relay. This IC is 16 pin IC from this we can use pin no.8 and 9 i.e. supply and other 7 pin are input-output pin from this 7 pin 4 pin are connect to 4 relay also we can use 1 k-ohm register through 1 LED because at input we get 12 V supply but this not capable for LED so, to avoid damage we can placed 1 K-ohm register at near to particular LED and the LED is use for indication purpose. Also we used diode i.e. freewheeling which can increased switching speed immediately and also disconnect supply through coil for energy discharge. The 12 V DC operated relay connect with four this is 4 microfarad 440 V AC capacitor this is individual connection of one relay connect to one capacitor in this way four capacitor and four relay are connect. We take 230 V AC input from voltage transformer at it give to relay and from this as output to provide to load common terminal then all capacitor are connect to each other and it give to CT terminal and transformer as neutral. These neutral points from CT. The CT is used to the measure current of 20 A and 1000:1 coil ratio. Also register is used as Burdon register from this CT, Neutral point is take for connect load. This CT is again connecting to microcontroller for measure current.We can connect load to load this circuit the microcontroller sense power, voltage, current from CT, power transformer, voltage transformer are get power, voltage, current, which can be display on LCD display .for this purpose we use 16*2 LCD display and it used potentiometer which attached to LCD for varying contrast as per our requirement.

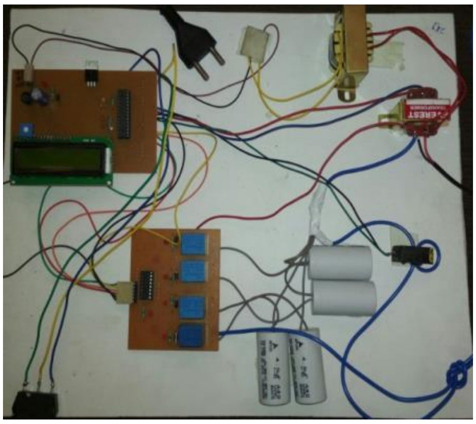


Fig.5.1Proposed System

In this way from load we can measure power, voltage, and current, power factor and from following conditions relay can be operated and all value is display on LCD

6.1 Conditions

Due to the inductive reactance power factor become poor, we have given condition for power factor correction we use four relay activation through relay driver IC. All condition given below in table.

Table No:6.1.1

Sr. no.	Pf range	Relay display condition	Capacitor condition
1.	Greater or equal to 0.9	All off	All off
2.	0.7 to 0.89	1 ON 3 OFF	1 connect in phase
3.	0.55 to 0.69	2 ON 2 OFF	2 connect in phase t
4.	0.4 to 0.59	3 ON 1 OFF	3 connect in phase
5.	0.39 to 0.1	4 ON	All connect phase

7. RESULT

Use of single phase transformer as load various readings are arrive, when single phase resistive load connected to secondary of transformer then we the resistance increases as well inductance of the transformer increases.When inductance of circuit increase through resistance then power factor reduces to low value because it is character of inductive circuits current lags voltage by 90.inductive reactance of circuit increases power factor goes on decreases ,at that instant capacitor added in circuit depend on how power factor low(shown in condition table). Below figure show the various reading taken at time of load(transformer).

Table No: 7.1

Load Current Value	**Before connecting capacitor in circuit**			
	V	**I**	**P**	**PF**
7A	219	3.59	738	0.59
6A	217	3.89	865	071
5A	216	4.48	970	0.80
3A	217	5.64	1235	0.88

Table No: 7.2

After connecting capacitor in circuit				**Relay condition after reading**
V	**I**	**P**	**PF**	

219	3.02	738	0.59	4Relay ON
217	3.20	865	071	3 Relay ON
216	3.90	970	0.80	2Relay ON
217	4.25	1235	0.88	1Relay ON

From above table we can say that, when inductive reactance of the circuit increase then power factor decreases power factor is inversely proportional to the inductive reactance.

8. CONCLUSION

It can be conclude that power factor correction techniques can be applied to the industries, power system and also households to make them stable and due to that the system become stable and efficiency of the system as well as the apparatus increases. The use of microcontroller reduces the costs. Care should be taken for overcorrection otherwise the voltage and current become more due to which the power system or machine become unstable and the life of capacitor banks reduce Installation capacitor bank for power factor correction will obtain profitable both sides consumer and electric flow. Thesis also shows capacitor bank was used extensively by the high power user as industry sector and commercial. Installation of capacitor bank can reduce reactive current consumption further minimize a losses. When the inductive reactance increase power factor decrease.Based on literature review those carried out, single phase power factor correction by using capacitor bank was still new and not as much of discuss. Project automatic power factor Correction this was developed based on idea and basic concept of three phase automatic capacitor bank. Idea and basic of control concept automatic capacitor bank are using microcontroller and switching operation use relay was applied in this project development.

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